

## BOOSTING CROP YIELD, ANIMAL HUSBANDRY ACTIVITIES AND NATURAL RESOURCES MANAGEMENT THROUGH INTEGRATED RESEARCH APPROACH FOR SUSTAINING SOCIO-ECONOMICAL STATUS OF TRIBAL FARMERS

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### ABSTRACT

A study was undertaken in Dang district of Gujarat state (India) from 2008–09 to 2013–14 under NAIP-III with an objective for sustaining socio –economic status of tribal farmers by boosting crop yield, animal husbandry activities and natural resource management through integrated research approach covering interventions viz. use of improved/ high yielding varieties, diversification / replacement of crops, backyard vegetable farming, scientific animal husbandry, fish farming, natural resources management including harvesting and arresting rain water and their use, soil conservation, expansion of surface irrigation and introduction of micro-irrigation systems, value addition and other income generating activities. The results of various activities were compared with baseline data and in cases impact analysis was done. Pigeon- pea crop recorded the highest percent increase in yield followed by ground nut, paddy, chick pea, nagli (ragi), niger, black gram crop and gross income for all these crops significantly increased over those of initial year (2008–09). Crop diversification/ replacement with soybean, turmeric ginger and okra respectively in place of prior crops paddy & nagli, niger, paddy and vari exhibited significant increase in income. Land and soil conservation works increased area under cultivation (32.5 ha), average crop yield (17 - 22%), and soil moisture storage (19-20 %) with reduction (45 - 60%) in erosion. Use of harvested and arrested rainwater increased irrigated area (26.0 ha) and crop production around 210 kg ha<sup>-1</sup>.

The expansion of surface irrigation facility boosted crop yield around 28 - 33 % with an additional higher income of 40 - 45%. Average enhancement of net income under sprinkler and drip was Rs 4394/- and Rs 7172/-per ha respectively. Vermi-composting activity played a role in generation of additional income and reduction in use of chemical fertilizers. Increase in annual income under HF/Jersey breed cow /farmer over indigenous and local breed of cow and under Mehsana or Murrah breed buffalo /farmer over local breed were statistically highly significant (0.01 level of significance) at the end of the year 2013. Fish farming and backyard vegetable farming also proved to be income generating or household consumption sources. Sewing works by tribal girls fetched an additional income of Rs 2200 to 2500 / year / girl. Various on and off campus short and income generating trainings and exposure visits were conducted for tribal farmers / farm women and farm literature were distributed for their skill development, empowerment and knowledge enrichment. Results clearly indicated that integrated research approach including crop - production related activities, scientific animal husbandry, fish farming, natural resources management, value addition and other income generating activities were of equal importance for sustaining socio – economic status of tribal farmers of the study area.

**KEYWORDS:** Integrated Research Approach, Boosting Crop Yield, Animal Husbandry, Natural Resource Management, Socio-Economic Status, Tribal Farmers

## INTRODUCTION

Absolute poverty, high livestock and high population pressure and degradation of production bases are some of the problems defying solution in most developing countries including India in these regions (Grewel *et al*, 2001). In high rainfall area of hilly terrain crop productivity generally varies low to high depending upon rain water use efficiency as on many occasions rainfall goes downstream and reach out of the zone. Natural resources conservation, integrated watershed management approach, improved agro-horticulture technology, crop diversification, scientific animal husbandry / fisheries/ poultry, value addition and various income generating activities are some of the most challenging aspects as are to be followed for improvement of livelihood in high rainfall areas.

The Dangs district is the smallest district of Gujarat state and is considered the poorest district out of 447 districts in India listed based on ranking of the index of backwardness by Planning Commission. The district comprising of 311 villages (situated at hilly undulating terrain) falls under South Gujarat heavy rainfall agro-climatic zone with average annual rainfall of about 2500 mm, where >93.00% populations are tribal and about 85% of population is dependent on rain-fed agriculture with insufficient land (1.85 ha per household) with low crop productivity due to several soil and crop related constraints like, highly undulating and uneven topography with coarse soil texture, low water holding capacity, shallow to medium soil depth, medium to high erosion, poor fertility status.

Thus, agriculture is not such a remunerative occupation as may perpetuate livelihood of tribal people. Moreover, illiteracy, remoteness, backwardness, dearth of marketable skills other than traditional ones, lack of modern/scientific agro-technologies are some of the major weaknesses of tribal inhabitant. Thus, socio-economic status of tribal farmers is poor. There is very little scope for horizontal expansion of land for cultivation. Only alternative to improve socio-economic status of tribal people is a shift towards vertical expansion and diversification of farm components through integrated research approach where, apart from agriculture, natural resources management, horticulture, agro-forestry and scientific animal husbandry/ fisheries get an importance simultaneously. Thus, keeping all the above point in view, a study was undertaken from 2008-09 to 2013-14 under National Agricultural Project-III in six villages of Dang District Gujarat state (India) for sustaining / improving socio-economic status of tribal people.

## MATERIALS AND METHODS

### Overview of Sites

A study was undertaken under National Agricultural Project-III in six operational villages of Dangs district of Gujarat namely, Sarvar, Sodmal, Kalamkhet, Chikhaldar, Motidabdar and Daguniya situated at hilly undulating terrain of Dangs district, with an objective to sustain / improve the overall socio-economic status of tribal domiciles. Sarvar, Sodmal and Kalamkhet villages come under “Sarvar cluster”, while Motidabdar, Daguniya and Chikhaldar villages come under “Chikhaldar cluster”. These villages come under South Gujarat heavy rainfall agro-climatic zone with an average (10 years) annual rainfall of 2801.8 mm in 74.3 rainy days. However, rainfall received during the study period of 2008, 2009, 2010, 2011, 2012 and 2013 were 3405, 1771, 2375, 2501, 1916 and 3175 mm respectively in 65, 48, 88, 69, 70 and 87 rainy days. The area falls under hyperthermic temperature regime with an *ustic* moisture regime. Geologically, villages come under

trappean basalts with litho-units Basalt which is hard in nature.

Villages have fair climatic conditions with well defined seasons exhibiting summer, rainy and winter. Soils of these villages are hilly undulating highly dissected piedmont plateau and escarpment slope are shallow with excessive relief. The soils are residual type derived from the trappean basalts. Though the rainfall is high, due to hilly undulating terrain, inadequate storage facility of rainwater, old/damaged dams and reservoirs and decreased forest cover there is huge loss of rainwater as runoff from the zone which in turn causing large scale erosion of nutrient-rich top soil with runoff water and getting completely washed away from the zone. Thus, there is frequent problem of management of excess rainfall during monsoon and after the cessation of monsoon (right from December-January onwards), villages suffer from acute scarcity of water to meet the demand of tribal farmers for their livelihood and also for successful agriculture. Farming is mainly rain-fed and irrigation facility is meager.

Farmers only in areas nearby to rivers or *nalas* or having well or bore water facility, go for *rabi* crops. More than 93% population of these villages is tribal with communities belonging to Bhil, Warli, Kokni, and Gamit tribes. Illiteracy, remoteness, backwardness, dearth of marketable skills other than traditional ones, lack of modern/scientific agro-technologies, are some of the major weaknesses of tribal inhabitant. The natural vegetation consists of deciduous forests interspersed with scrub forest which includes Teak (*Tectona grandis*), Bamboo (*Dendrocalamus strictus*), and Australian babul (*Acacia auriculiformis*) and Catch tree/ Khair (*Acacia catechu*) etc. Other forest species viz., saru, baval, gulmahor, raintree, spethodia, karanj, arjun sadad, subabul, jack fruit, mango, cashew, sapota, tamarind, aonla, ber are also found in scattered form in the forest zone of these villages.

Location, land use and number of house hold in each village from study area are given in Table 1. The cultivated land use consists of paddy and minor millets as the major crops followed by Black gram, Groundnut, Vari, Tur, Niger, etc. during *kharif* and Groundnut, Gram and Vegetables are grown during *rabi* season. Because of coarse soil texture, low water holding capacity, shallow to medium soil depth, medium to high erosion, poor soil fertility status, flat to high sloppy land and lack of modern/scientific agro-technologies agriculture average crop production is low and as a result only agriculture is not that remunerative as to perpetuate socio-economic status of tribal people. So, about 35 to 50% of the tribal population goes out of the zone for 6-7 months for livelihood support. Farmers are socio-economically poor. Only alternative to improve socio-economic status of tribal people is a shift towards vertical expansion of land through diversification of farm components by integrated research approach where, apart from agricultural crop production, natural resources management, horticulture, agro-forestry and scientific animal husbandry/ fisheries come under same umbrella and must get importance simultaneously.

**Table 1: Location and Land Use in Study Area**

Name of Village	Location	Land Use			
		Geographical Area (ha)	Cultivated Area*(ha)	Forest Area(ha)	Pasture (ha)
Sarvar	20° 50'55'' N, 73° 36'55'' E	460.0	332.0	120.5	7.5
Sodamal	20° 51'40''N , 73° 37'10''E	193.4	98.6	84.4	10.3
Kalamkhet	20° 51'55''N, 73° 36'39''E	212.1	114.1	90.5	7.5
Moti Dabdar	20° 41'7''N, 73° 35'50''E	738.7	309.5	357.6	2.9

**Table 1: Contd.,**

Daguniya	20° 42'33''N, 73° 35'58''E	871.5	255.8	557.6	21.3
Chikhaldha	20° 38'31''N, 73° 36'6''E	105.6	34.9	45.5	26.0

\*Includes habitat area

### Field Survey

Field survey was done using base map (1:16666) provided by BISAG, Gandhinagar along with village cadastral map (1:3960). An Inclinometer/ Abney level was used to determine the slopes while, depth of soil was estimated by using different types of augurs. Further, altimeter was utilized in order to know the elevation of land during traversing. The soils of villages were categorized under varying depths (d<sub>1</sub> - d<sub>4</sub>), degree of soil erosion (e<sub>1</sub> - e<sub>4</sub>) and slopes (A -G).

### Baseline Survey

The baseline data were collected through well defined pre - tested questionnaires as suggested by Monitoring and evaluation team of NAIP. Two different questionnaires were used to collect the village profile and farm household profile, separately for sarvar and chikhaldha cluster. All the farm householders were selected for baseline survey. Village- wise list for two clusters were prepared classifying marginal, small, medium, large and agricultural landless laborers. Apart from above data on 1) ratio of land: Human : cattle : DAP : Milch animal based on total survey ecosystem and crop land, 2) productivity of major crops, 3) village-wise cropping intensity, 4) Age, Occupation, Education - wise distribution of villagers, Distribution of villagers based on 5) type of house, 6) Possession of vehicles , 7) Type of family 8) slab of annual income 9) saving, 10) Debit, 11) use of information source, 12) Vegetable farming and 13) Adoption of seed treatment were collected. However some of the baseline data are included in the result section for discussion and interpretation purpose and rest are not included.

### Various Technological Interventions

Depending upon soil, agro-climatic and socio-economic condition of tribal people, following major interventions with different activities as under Table 2 were carried out for improvement of socio-economic status of tribal people.

**Table 2: Major Research Interventions and Details of Activities**

Major Interventions	Details of Activities
• Introduction of improved/HY varieties of different crops with package and practices	Crops with variety-Paddy (IR-28, GR-7), Nagli (GN-4, GN-5), Pigeon pea (Vaishali, C-11, GT-101), Niger (NRS-96-1), Black gram (GG-1), Ground nut (GG-11, TG-37A, GJG-9), Chick pea (GG-1, GG-2)
• Crop diversification/replacement and backyard vegetable farming with package of practices	Field crops with variety- Soybean, Turmeric, Ginger, Soybean, Okra Backyard vegetable farming- okra, brinjal, Bittergourd, Bottlegourd, Spongegourd, Chilli, Ridgegourd, Pumpkin, and other creeping vegetables
• Soil and water conservation, and rain water harvesting	Land leveling, Farm Bunding, soil + stone bunding, Stone bunding, trenching, temporary check dam (TCD), repairing of old check dam, construction of small farm ponds.
• Expansion of existing surface irrigation facility	Construction of water tank at higher elevation, development of surface irrigation network through PVC pipeline
• Introduction of Micro Irrigation Systems,	Installment of sprinkle irrigation and drip irrigation system
• Employment Generation through Agro Processing/Value Addition and other project activities	Formation of self-help groups (SHGs) for various income generated activities. Nagli Papad making, Dal flour and spices powder making. Sewing work, nursery raising and field oriented project activities,

	Production of vermin-compost and compost from waste /natural resources, low cost green house (LCGH) activity.
• Scientific animal Husbandry and Fish farming	Animal health care camps, supply of nutrient rich animal feed, scientific training on animal husbandry and fish farming
• Exposure visits, farmers meetings, off and on campus scientific trainings for skill upgradation of tribal farmers and women on agriculture and allied subjects	Exposure visits to progressive farmers' field, Research stations, SAUs farms and Agril. Univ. of Rajasthan, Pune (MH), progressive dairy farm, co-operative dairies, etc. Scientific off and on campus trainings to tribal farmers/ farm women /girls/ boys by experts of various subjects on- packages and practices of important crops, landscaping and gardening, repair and maintenance of irrigation equipments, basic wood work, scientific poultry farming, preparation of vermin-compost and compost, preparation bakery products, pickles making from various fruits and vegetables, papad making from Nagli and other millets, use of modern farm equipments / tools including MIS system etc.
• Awareness creation and knowledge enrichment on various aspects of agriculture and allied subjects	Distribution of printed farm literatures, booklets and folders etc. Formation of farmers / farm- women interaction groups for discussion among group members for understanding and practical implementation of scientific know-how /agro-technology

### Impact Assessment

Impact assessment of major interventions for the two clusters of Dangs district was done based on “t” test (Panse and Sukhatme, 1985) of data obtained in any particular intervention by selecting arbitrarily 25 per cent beneficiary farmers for that particular intervention in order to know the impact of that intervention on income enhancement / livelihood improvement of tribal farmer under the project. However, for some interventions where baseline data was not available, results were interpreted only in terms of additional increase in income.

## RESULTS AND DISCUSSIONS

### Soil Depth, Erosion and Slope

The distribution of soils under varying depth (cm), erosion and slope (%) of six villages are presented in Table 3. The result revealed that soil depth varied from  $d_1$  to  $d_4$  i.e. less than 7.5cm to 90cm. Similarly, soil erosion and soil slope varied from  $e_1$  to  $e_4$  (sheet erosion to big gully erosion) and A to G (<1% to 35%) respectively in these villages under cultivated + degraded forest land. However,  $d_2$  i.e. 7.5-22.5 cm shallow soil depth,  $e_2$  i.e. rill erosion and D soil slope i.e. 5-10% covers the maximum area in these villages under cultivated + degraded forest land. The study further revealed that soil depth, soil erosion, higher content of coarse/ rock fragments in soil , land slope, low moisture holding capacity and imperfect to excessively drainage condition were some major crop production related constraints. However, soils of lower elevation were of higher depth and comparatively more productive. Tribal farmers, because of their unawareness, are not judiciously utilizing the land for different crops. A higher degree of erosion and slope indicated that erosion control measures as well as soil moisture conservation including rainwater harvesting activity would be necessary for these villages for good agriculture.

### Baseline Survey

Total 843 tribal household were surveyed for Sarvar and Chikhaldha cluster. Number of household surveyed from Chikhaldha, Motidabdar, Daguniya, Sarvar, Sodmal and Kalamkhet were 60,170, 176, 196, 121 and 120 respectively. Productivity of different crops at baseline (2008) is mentioned in the respective table for discussion and interpretation. Out of 437 household of Sarvar cluster, 350 household belongs to small and marginal family and 59 belongs to landless

family, while out of 406 household of chikhaldha cluster, 350 household belonging to small and marginal family and 33 belongs to landless family. Out of 409 either small and marginal or landless household of Sarvar cluster, 387 family come under < Rs 11000 annual income group and only 22 family belong to medium income group (Rs 11000 - 35000/-). Only 28 family of Sarvar cluster belong to either medium or large farmer. Similarly, Out of 382 either small and marginal or landless household of Chikhaldha cluster, 368 family come under < Rs 11000 annual income group and only 14 family belong to medium income group (Rs 11000-35000/-). Only 24 family of Chikhaldha cluster belong to either medium or large farmer. Baseline cropping intensity for Sarvar and Chikhaldha cluster were 86.55 and 71.32 % respectively.

### **Enhancement of Agricultural Productivity and Profitability through High Yielding or Improved Varieties**

The result on enhancement of agricultural productivity and profitability through high yielding / improved varieties of field crops with package of practices revealed (Table 4) that the highest percent increase in crop yield and gross income per ha were recorded under Pigeon- pea followed by ground nut, paddy, chick pea, nagali, niger, black gram crop. The results clearly suggested that tribal farmers should grow pigeon- pea and groundnut crops also in more areas along with paddy and nagli during *kharif* and chick pea (under conserve moisture and supplementary irrigation facility) in large area during *rabi* for higher crop yield as well as profitability which as a result may improve the livelihood of tribal farmers at this villages. The result on impact assessment of promotion of high yielding/ improved varieties revealed that (Table 5) gross income significantly increased for all the crops at the end of project. However, the highest gross income was observed under groundnut crop followed by check pea, pigeon pea, niger, paddy, nagli and black gram. The results indicated that tribal farmers should grow ground nut, check pea, pigeon pea in large areas as compared to other crops for significantly higher gross income which in turn would boost their socio-economic status.

### **Crop Diversification/ Replacement and Backyard Vegetable Farming**

Crop diversification/ replacement activity on selected farmers' field with soybean in place of paddy and nagli, Turmeric in place of niger, ginger in place of paddy, okra in place of vari, was carried out during kharif with appropriate package in possible area for improvement of their livelihood. The result reviled that all these crops exhibited (Table 6) significant increase in income over crops prior to project. Backyard vegetable farming indicated as source of additional income or source of additional vegetables to meet household demand. Depending upon the area available for raising different vegetables under backyard vegetable farming, farmers harvested during monsoon and post-monsoon period (July-Jan) vegetable is equivalent to Rs 3150/- per household

### **Land Levelling and Soil Conservation**

Land levelling activity carried out in two clusters proved highly beneficial for increasing crop productivity and cropping intensity nearby to residential area in land with about 5% slope (Table-7). This activity increased the average crop productivity to the tune of 18.5% and an increase in area under cultivation of 32.5 ha. Land and soil conservation works through farm (earth) bunding, soil + stone bunding, stone bunding and trenching etc. are considered to be another most important and crucial activity to check soil erosion, enhance soil moisture storage, higher crop production and possible alteration of cropping pattern in undulating sloppy land of these villages. So, farm (earth) bunding, soil + stone bunding, stone bunding activities were carried out in 528 ha of sloppy considering slope of land and suitability for this activity (Table 8). Trenching was done only a small portion of land (0.50 ha) and result of which is not reported here. The results indicated an increase in average crop yield to the tune of 17 – 22 %. Soil moisture storage was found to

increase to about 19-20% with reduction in erosion to about 45 - 60% due to these conservation measures. Moreover, activities made certain areas (27.14 ha) possible for other / high value crop cultivation (27.14 ha).

### **Rain Water Harvesting**

Rain water harvesting and arresting activities through development /construction work of small farm pond, temporary check dam (TCD), loose boulders, farm bunding and repairing of check dams being most essential components of arresting rain water for hilly, sloppy and high rainfall areas of this terrain, were covered up for the benefit of 204 farmers in Chikhalda and Sarvar cluster (Table 9). The result reveled that owing to these activities area increased under irrigation was 26.0 ha which accounted 13.5% increase of irrigated area with an average increase in crop production by around 210 kg/ha.

### **Expansion of Surface Irrigation Facility and Introduction of Micro-Irrigation Systems (MIS)**

The expansion of surface irrigation facility on increase in crop yield and income of farmers of Chikhalda village are presented in Table 10. The result revealed that expansion of surface irrigation facility in 14.4 ha area involving 38 tribal farmers of Chikhalda village caused an increase in yield of different crops to the tune of 28 to 33 per cent with an additional increase in income of tribal farmers to the tune of 40 to 45 per cent. Introduction of micro-irrigation systems (MIS) was done in collaboration with Gujarat Green Revolution Company (GGRC), Gujarat under NAIP-III (contribution 12.5%) with farmers' monetary contribution of 12.5%.

Major crops taken in the field of tribal farmers under MIS were Chickpea, Ground nut, water melon, paddy (partially), bringal, mango and cashewnut covering 29 ha land of three villages in Chikhalda cluster (Table 11). MIS activity proved to be highly pay-off intervention in terms of average increased net income of Rs 4394/- per ha under sprinkler irrigation system with an additional benefit of low expenditure on labour (Rs 350/ha). However, net increase in income under drip was recorded to be Rs 7172/- per ha with an additional benefit of low expenditure on labour (Rs 1400/ha). Thus, this activity is of immense importance for tribal habitat of these villages in respect to water saving (or increase in area under irrigation with the saved water), higher water use efficiency and higher crop production and income which ultimately helped in enhancing socio-economic status of tribal farmers.

### **Income Generated Activity and Employment Generation**

Low cost green house (LCGH) activity has also proved to be as one of the livelihood enhancing venture for tribal farmers in relation to additional income generation through raising seedling of various vegetable crops like, methi, amaranthus, chilli, tomato, brinjal, coriander, cabbage etc. (data not shown). However, higher initial investment and heavy rainfall situation, the two major constraints come always in the way of poor tribal farmers of these areas for taking up this as successful venture. Vermi-composting (Table 12) as well as compost preparation activity (data not shown) not only proved to be very good natural resource management venture for self employment tribal women, but also contributed to the improvement of livelihood of tribal people through generation of additional income, reduction in use of chemical fertilizers as well as Sustained / improved soil health (Table 12). Afforestation of tree plants and plantation of fruit crops (mango, sapota, custard apple, cashew nut, drumstick, etc (Table 13) on boundaries as well as in the vicinity of residential area were found not only effective to check soil erosion to certain extent but also indicated a good sign of future source of additional wood and fruits which would ultimately support to improve the socio-economic status of tribal people.

Under scientific animal husbandry intervention an attempt has been made to improve the existing breed of cow and buffalo. Artificial insemination, animal health care camp, fodder crops cultivation, supply of nutrient rich mineral feed, scientific training for animal keeping were promoted, the farmers were motivated to rear cross breed cows. This activity has helped them in increasing income per cow and buffalo. The result (Table 14) revealed that average increased annual income for HF/Jersey cow/farmer over indigenous breed cow was Rs 11078 in these villages, while average increased annual income for HF/Jersey cow/farmer over local breed cow was Rs 7059. In case of buffalo, average increased annual income for Mehsana or Murrah breed /farmer over local breed was Rs 27124. So, far statistical analysis concern all the “t” values were significant at 0.01 level significance indicating highly significant increase in income at the end of the year 2013.

Activity carried out on fish farming during 2010-11 and 2011-12 post rainy seasons in stagnated (confined) rain water at *nala* in both the clusters proved highly beneficial. Seedlings of fish (of Rs 2400 in 2010-11 and Rs 3000/- in 2011-12) were allowed to grow for about four and half month in stagnated water involving 24 tribal farmers in two groups. Farmers harvested 360 kg and 400 kg fishes respectively in 2010-11 and 2011-12 from which earned them Rs 21600/- (2010-11) and Rs 24000/- (2011-12) by selling fishes in nearby local market @Rs 60/kg.

About 11,500 man-days were created for the tribal farmers and women in carrying out different field and other activities of the project and the remuneration received by farmers/ farm women through such project oriented employment helped positively boosting their livelihood. SHGs are involved in various income generation activities (IGA) like, preparation of Nagali papad, making Dal flour spices powder, vermin-compost and compost preparation, vegetable and forest nursery raising, threshing of paddy which help them enhancing their income and improve their socio-economic status.

### **Empowerment and Skill Development**

Trainings were imparted to tribal girls/women and farmers from time to time at University Main campus/ Research Stations/ Technology Dissemination Centers in order to empower them and improve their skill / know – how on various subjects of agriculture and allied fields. Year-wise, activity-wise numbers of trainees are given in Table 15. Total 1150 numbers of farmers and farm- women were educated on package of practices and technologies on different aspects related to agriculture, horticulture and Animal Husbandry through on campus training while, 2315 number of farmers / farm- women were involved in off- campus training on various agriculture and allied aspects.

Apart from short term training, vocational training on sewing works was imparted to 70 tribal girls. 20 sewing machines were given under the project in 2010 to selected 20 trained tribal girls out of 70 after taking 20% contribution from each girl. During the year 2011-13 each of 20 tribal girls earned an additional income of Rs 2200 to 2500/year. Landscaping and gardening training was imparted to 9 farmers’ son at college of horticulture & forestry, NAU, Navsari, while training on “Repair and maintenance of irrigation equipments was imparted to another 10 farmers’ son”, and “Basic wood work training were also imparted to another 10 farmers’ son” at ITI, centre Billimora (Navsari). Each of trained farmers’ son is earning on their own way to some extent to improve their family status.

Training on scientific poultry farming was imparted to 10 boys. Similarly, training on preparation various bakery products were imparted to 38 girls/women at bakery shala Navsari Agril. University, Navsari. A special training on “pickle making from various fruits and vegetables was imparted to 56 tribal girls/women” at centre of excellene on post

harvest technology centre, NAU, Navsari. Similarly, a special training on papad making from Nagli (Ragi) and other millets was imparted to 72 tribal girls/women by the expert person. All the trained girls /women are earning to some extent on their own and increasing the household income.

3420 numbers of farmers/farm women were benefited (Table 15) through exposure-cum-learning visit organized by NAU and BAIF at main campuses of Gujarat state Universities, different sub-centers of NAU, field of progressive farmers, dairies in Gujarat, BAIF research centers, Krushi Melas organized by NAU etc. 3432 numbers of farmers/farm women attended different work / research oriented meetings organized under the project. 57 folders and 6 booklets on various topics covering package of practices of crops, natural resource management and animal husbandry were distributed in printed form for the enrichment of knowledge of tribal farm families for better farming.

The above results clearly indicated that there is huge scope for enhancing income of tribal farmers by boosting agricultural activities like, use of improved/HYV along with their package of practices, diversification / replacement of crop, backyard vegetable farming etc. Apart from only agriculture, scientific animal husbandry, fish farming also proved an important component in enhancing income of tribal farmers further. Natural resource management like, preparation of vermicompost from waste material, rain water harvesting and use, soil conservation, surface irrigation, introduction of MIS, value addition of produce and other income generating activities boosted the overall income of tribal farmers further. Thus it can be concluded that apart from agriculture occupation, animal husbandry, fish farming, natural resource management, value addition and other income generating activities should be given equal importance and should be implemented simultaneously in integrated way for improving/ sustaining overall socio-economic status of tribal farmers of the study area.

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## APPENDICES

Table 3: Distribution of Soil under Varying Depth (cm), Erosion and Slope (%) of Six Villages

Soil Depth (cm)	Area (ha)		Soil Erosion	Area (ha)		Soil Slope (%)	Area (ha)	
	Cultivated + Degraded Forest	Forest Land		Cultivated + Degraded Forest	Forest Land		Cultivated + Degraded Forest	Forest Land
d <sub>1</sub>	21.45	035.12	e <sub>1</sub>	87.97	0879.1	A	30.10	01.93
d <sub>2</sub>	1049.35	1024.00	e <sub>2</sub>	973.00	0251.0	B	55.83	01.93
d <sub>3</sub>	52.23	159.20	e <sub>3</sub>	79.62	0082.0	C	234.60	25.09
d <sub>4</sub>	21.84	37.63	e <sub>4</sub>	4.27	4381.0	D	613.60	74.30
						E	122.70	376.70
						F	54.57	690.70
						G	33.30	85.11

N. B: d<sub>1</sub> :<7.5 cm, d<sub>2</sub>: 7.5-22.5 cm, d<sub>3</sub>: 22.5-45.0 cm, d<sub>4</sub>: 45-90 cm, A= <1%, B=1-3%, C=3-5%, D=5-10%, E=10-15%, F=15-25%, G=25-35%, e<sub>1</sub>: sheet erosion, e<sub>2</sub>: rill erosion, e<sub>3</sub>: small gully, e<sub>4</sub>: big gully

Table 4: Promotion of Improved / High Yielding Varieties in Approved Villages of Dangs District

Name of Crop (Variety)	2008		2013		Productivity (kg/ha)		Percent Increase in Productivity	Gross Income (Rs/ha)		Percent Increase in Gross Income		
	Adoption by Tribal Farmers				2008	2013		2008	2013			
	Numbers	% of Total	Numbers	% of Total								
Paddy (IR-28, GR-7)	126	15.00	519	62.00	1200	1683	40.25	8280	13464	62.60		
Nagli (GN-4, GN-5)	67	8.00	468	56.00	596	640	7.38	7136	9240	29.48		
Pigeon pea (Vaishali, C-11, GT-101)	00	0.00	544	65.00	350	692	97.71	14700	30825	109.69		
Niger (NRS-96-1)	84	10.00	394	47.00	1000	1250	25.00	28000	35000	25.00		
Black gram (GG-1)	00	0.00	234	28.00	600	644	7.33	24000	25760	07.33		
Groundnut (GG-11, TG-37A, GJG-9)	42	5.00	343	41.00	1200	1450	20.83	30000	50750	69.16		
Chick pea (GG-1, GG-2)	00	0.00	460	55.00	950	1200	26.32	30400	48000	57.89		

Table 5: Impact Assessment of Promotion of Improved/High Yielding Varieties

Name of Crop (Variety)	Varieties at Baseline (2008)		Increase in Gross Income from Baseline, Rs/ha (2008 to 2013)		“t” Value
	2008	2013	2008	2013	
Paddy (IR-28, GR-7)	Local/hybrid		5184		4.072**
Nagli (GN-4, GN-5)	Local		2104		3.811**
Pigeon pea (Vaishali, C-11, GT-101)	Local		16125		5.109**
Niger (NRS-96-1)	Local		7000		2.889*
Black gram (GG-1)	Local		1760		3.208**
Ground nut (GG-11, TG-37A, GJG-9)	Local		20750		4.011**
Chick pea (GG-1, GG-2)	Local		17600		3.887**

\*\* and \* are Significant at 0.01 and 0.05 level, respectively

Table 6: Impact Assessment on Crop Diversification/Replacement in Approved Villages of Dangs Districts

No. of Farmers Selected	Prior crop (Year 2008)	Existing Crop (Year 2013)	Gross Income Rs/ha prior	Income (Rs/ha) End of Project	Increase in Gross Income from Prior Crop (Rs/ha)	“t” value
71	Paddy	Soybean	8280	13560	5280	1.852*
24	Niger	Turmeric	28000	86249	58249	5.963**
13	Paddy	Ginger	8280	236400	228120	-----
71	Nagli	Soybean	7136	13560	6424	2.321*
87	Vari	Okra	11600	71625	60025	5.745**

\*\* and \* are significant at 0.01 and 0.05 level, respectively

**Table 7: Effect of Land Leveling Activity\* on Increase in Average crop Yield and Cultivated Area in Two Clusters**

Type of Work	Cluster	Area Suitable for Lan Leveling (ha)	No. of Farmers Covered up	Area Covered, ha (also in Percentage)	Avg. Cost /ha	Increased in Avg. Crop Productivity (%)	Area Increased Under Cultivation due to Intervention (ha)
Land leveling	Chikhaldha	30	168	30 (100%)	2000	18.1	30
	Sarvar	5	7	2.5 (50%)	2000	18.9	2.5
	Total	35	175	32.5 (92.86%)	2000	18.5	32.5

\*Jointly done by NAU, Navsari and BAIF, Vansda (Gujarat)

**Table 8: Effect of Various Land Conservation Measures (Farm Bunding , Soil + Stone Bunding and Stone Bunding)\* on Average Crop Productivity in Two Clusters**

Type of Land Conservation Measures	Name of Cluster	Total Area Suitable for Land Conservation (ha)	No. of Farmers Covered Up	Area Covered (ha)	Average Cost (Rs) / ha	Increase in Average Crop Yield (%)	Area Increased under Cultivation due to Intervention (ha)	Increase in Moisture Storage %	Reduction in Soil Erosion %
farm bunding , soil + stone bunding and stone bunding	Chikhaldha	444.16	237	293 (66%)	11500	17.0 to 21.8	14.00	19.0-19.8	45.0-52.5
	Sarvar	403.11	343	235 (58%)	11500	18.2 to 22.0	13.74	19.7-20.0	48.9-60.0
	Total	847.27	591	528 (65.31%)	11500	17.0 to 22.0	27.14	19.0-20.0	45.0-60.0

\*Jointly done by NAU, Navsari and BAIF, Vansda (Gujarat)

**Table 9: Effect of Rain Water Harvesting and Arresting Activities on Average Crop Production in Chikhaldha and Sarvar Cluster**

Sr. No.	No of Farmers Covered	Activity Performed in Area (ha)	Total Cultivable Area (ha)	Area of Irrigated Crop Cultivation (ha)		Additional Area under Benefit (ha) from Harvested/ Arrested Rainwater	Per cent Increase in Irrigation Area	Increase in Average Crop Yield due to Supplementary Irrigation (kg/ha)
				Year 2008	Year 2013			
1	204	63.00	1144.94	194.64	220.64	26.00	13.35	210

**Table 10: Expansion of Surface Irrigation Facility in Farmers' Field of Chikhaldha Village**

Name of Cluster & Village	Chikhaldha
No. of Farmers were covered up	38
Total area covered up	14.40 ha
Length of PVC pipeline network for surface irrigation	2355 m (from upper to river bank on farmers field)
source of irrigation water	Ambika river flowing adjacent to Chikhaldha village
Method of water drawing from river	Lifting by 10 HP motor installed in concrete foundation structure at the bank of river at lower elevation
Storing of water drawn from river	Construction of water tank at higher elevated position of the village
Driving force of irrigation	Gravity flow from upper elevated water tank to fields situated at various lower positions.
Types of crops grown before creation of surface irrigation facility	Paddy, nagli, pigeon pea, black gram
Type of crops being grown after expansion of surface irrigation facility	Paddy, pigeon pea, water melon, okra, cluster bean, ground nut, onion, cow pea & brinjal and mango, cashewnut plantation
Average additional yield increase per ha	28 to 33%
Average additional increase in income per ha	40 to 45%

**Table 11: Promotion of Micro-Irrigation System**

Promotion of Technology	No. of Farmers Adopted		Area (ha) Under Irrigation		Decrease in Expenditure Over Surface Irrigation on Labour/ha (Rs.)	Net Benefit from Crop Yield Rs/ha/ Farmer
	2008	2013	2008	2013		
Drip irrigation	0.00	37	0.00	17.80	1400	7172
Sprinkler irrigation	0.00	70	0.00	70.00	350	4394

**Note:** Reduction in expenditure on labour/ha: Reduction in expenditure on labour in drip and sprinkler irrigation system was computed in comparison to flood irrigation system. Farm operations such as weeding, irrigation, application of fertilizers, spraying of pesticides, preparation of beds for irrigation etc. were considered while computing the expenditure on labour

**Table 12: Production of Organic Inputs**

S. No.	Name of Organics	No of Units		Earning		Decrease in use of Chemical Fertilizers (Approx.)
		2008	2013	Quantity Produced/ Unit/ Year (kg)	Rs/Unit	
1	Vermi-Compost	--	52	1395	4185(Rs. 3/kg)	14kg Urea 50kg DAP

**Table 13: Afforestation and Plantation of Fruit Crops**

Sr. No.	Cluster	Fruit Plantation at 2008	Fruit/Tree plantation (no.) Done From 2009 to 2011	Survival Fruit/Tree Plant as on 2013	No. of Farmers Involved	Total Area Covered
1.	Chikhaldha and Sarvar	4155*	88819 (Mango, Cashew, Guava, Lemon, Sapota, Custard apple & other Forest spp.)	45310	937	89.40

\* Some fruit plantation was done earlier in these villages by BAIF research foundation, Vansda (Gujarat)

**Table 14: Impact Assessment of Animal Husbandry Activity on Milk Production**

Milch Animal	Year 2008		Year 2013		Income Rs/Year/Animal		Increase in Gross Income Rs/Year (2008 to 2013)	“t” Value
	Breed	Milk prod. (Lit.) /Animal/Year	Breed	Milk prod. (Lit.) /Animal/ Year	2008	2013		
Cow	Indigenous	1102	HF/Jersey	1770	16237	27315	11078	5.65**
Cow	local	1028	HF/Jersey	1439	15139	22198	7058	3.65**
Buffalo	Local	183	Mehsani/m urrah	976	3805	30929	27124	6.15**

\*\* and \* are significant at 0.01 and 0.05 level, respectively

**Table 15: Details of Exposure Visit, Meeting and on/off Campus Training Programmes\* for Beneficiary Farmers / Farm Women of Dang**

Year	No. of Activities	No. of Participants	Subjects
<b>(A) Exposure Visit</b>			
2008-09	12	568	Research stations, KVKS and watershed development area
2009-10	40	1549	Research stations, progressive dairy farm, Exhibitions, watershed development area, Agriculture, Horticulture, MIS, Animal Husbandry,

			Agroforestry, University krishi mela .
2010-11	24	911	Research stations, SAUs Farm, KVKS, milk collection societies, Central Research Station BAIF-Pune, University krishi mela, Animal Husbandry
2011-12	06	175	Research Stations, SAUs Farm, KVKS, Co-Operative Dairy. Onion Cultivation Practices (Salar mullar) and MIS at Jalgaon
2012-13	09	217	Research stations, Animal Husbandry, MIS at NAU, greenhouse/polyhouse, floriculture / high-tech horti. farm
<b>Total (A)</b>	<b>91</b>	<b>3420</b>	
<b>(B) Farmer Meeting</b>			
2008-09	5	193	Project profile, implementation related issues crop production technology
2009-10	20	821	Project profile, recommended crop technology/inputs, Horticulture/ Agroforestry, Animal Husbandry, farm problem solution.
2010-11	18	932	Micro-irrigations, problem solution related to field crops and Animal Husbandry.
2011-12	5	272	Animal Husbandry, Agroforestry, MIS. Value addition, water harvesting
2012-13	28	1214	Farm inputs, Micro-irrigations, problem solution related to field crops and Animal Husbandry.
<b>Total (B)</b>	<b>76</b>	<b>3432</b>	
<b>(C) On Campus Training</b>			
2008-09	01	35	Soil conservation and watershed related activity
2009-10	05	372	Artificial insemination, package of practices of major crops, Nagali papad making, vermicomposting and composting
2010-11	07	149	Artificial insemination, masonry training for youths, Nagali papad making, vermicomposting and composting
2011-12	06	170	Artificial insemination, package of practices of major crops, Nagali papad making, rain water harvesting, MIS, soil and water conservation
2012-13	18	424	Value addition on various products and preparation of bakery products
<b>Total (C)</b>	<b>37</b>	<b>1150</b>	
<b>(D) Off Campus Training</b>			
2008-09	12	358	Crop planning & production, vermicomposting and composting soil health
2009-10	22	616	vermicomposting and composting, paddy cultivation, use of biofertilizer, livestock health, nursery preparation and soil health
2010-11	08	151	package of practices of major field crops, animal husbandry, plant protection, use of hand tools, vermicomposting and composting, low cost green house
2011-12	08	332	use of small hand tools/implements, vermicomposting and composting, nursery preparation, value addition, low cost green house
2012-13	18	858	Vermicomposting, nursery preparation, poultry management, mushroom cultivation and soil health
<b>Total (D)</b>	<b>68</b>	<b>2315</b>	

\*Jointly conducted by NAU, Navsari and BAIF, Vansda (Gujarat)

